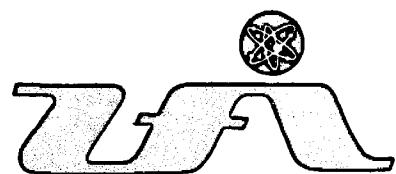
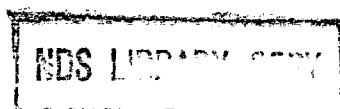


INDC/GDR/-23/G/E



**Academy of Sciences of the GDR
Central Institute for Isotope and Radiation Research
Leipzig**

B. Letz

Use of Nuclear Data Files

at ZfI Leipzig

ZfI-28

November 1982

Paper - 8th International Meeting
on Factografic Information for
Nuclear Research and Technology,
Dresden, Sept. 13-17, 1982

Herausgeber: Akademie der Wissenschaften der DDR
Zentralinstitut für Isotopen- und Strahlen-
forschung (RIS 0903)
DDR 7050 Leipzig, Permoserstr. 15
Direktor: Prof. Dr. habil. Dr. sc. K. Wetzel

Redaktion: Akademie der Wissenschaften der DDR
Zentralinstitut für Isotopen- und Strahlen-
forschung, Informations- und Rechenzentrum,
Wissenschaftliche Redaktion ZIDIS
DDR 7050 Leipzig, Permoserstr. 15
Telefon: 28 10 18 oder 2 39 22 72

Chefredakteur: Fachinf. Dipl.-Lehrer R. Schröter

Innerbetriebliche Druckgenehmigung: ZfI/FR-83/50-21

Zentralinstitut für Isotopen-
und Strahlenforschung
der AdW der DDR

B. Letz

Use of Nuclear Data Files at ZfI Leipzig

Factographic databases especially in the field of physics are not an invention of the last years or as one may assume a creation of this meeting now held the 8th time. Already in the last century it has been realized that experimental information was not available in an easy manner, because it was published in the journals concerning the actual problems of scientific investigations. For scientists who needed this data the problem of finding the 'best' and most 'modern' value arose.

In the past century the publication of Landolt-Börnstein tables (first published in 1883) was probably the best attempt to improve this situation /1/.

Today this method of creating data tables and handbooks is still possible. Behrens /2/ estimates that today about 3000 compilations of physical data are existing. This number is still growing, because all over the world research groups, national and international programmes create new data collections.

The importance of nuclear data among this wide field of physical data collections led to interesting developments. Some of them should be discussed in this paper.

The use of nuclear data covers today:

- fundamental and applied research
- medicine
- control of industrial processes
- nuclear power industry
- nuclear safeguards
- geology
- environmental research etc.

A detailed discussion of this e.g. was given by Seeliger /3/. The field of nuclear data on principle may be subdivided into three major categories:

- nuclear structure data
- nuclear decay data
- nuclear reaction data

For all this data categories today large databases are established. The problem of collecting and evaluating this giant amount of data is becoming an own scientific activity /4, 5/.

The evaluation procedures established now ensure for a great variety of user interests the existence of "best" or "recommended" commonly so called evaluated data. For the data categories mentioned above international standard data files (usual on magnetic tapes to enable its computerized handling) are available. The adopted standard formats and files are:

nuclear structure and decay data /6/:

evaluated data:	ENSDF
references:	NSR

neutron reaction data:

experimental data:	EXFOR
evaluated data:	ENDF/B-V
references:	CINDA

charged particle nuclear data:

experimental data:	EXFOR
evaluated data:	EXFOR
references:	by BNL

photonuclear data:

experimental data:	EXFOR
references:	catalogue by MGU

These international standard files are complemented by smaller specialized databases. The number of this databases is still growing and only the activities of the Nuclear Data Section of the IAEA allow to select the datafile of interest among them and to receive it in a relatively easy way /7/.

The international activities to obtain nuclear structure and decay data information are given in fig. 1. In addition to this figure the responsibilities of the mass chain evaluation groups are given in tab. 1 /6/. This international community tries

to ensure the 4-years-cycle for the evaluation of nuclear structure and decay data.

According to this scheme given in fig. 1 the Central Institute for Isotope and Radiation Research owns the position of an user. Periodically the Institute receives exchange tapes of NSR and ENSDF. The procedure of handling ENSDF (Evaluated Nuclear Structure Data File) is given in fig. 2. The tapes we receive undergo at first a test of their characteristics and content. This first test gives as a result a first catalogue of datasets. The IDENTIFICATION - Records which describe the datasets and serve as the basis for all retrieval programmes are also used to build up an INDEX file on tape or disk. This index allows the production of Z-ordered catalogues and retrievals regarding Z. The ENSDF file itself only allows access by mass number A and nuclid-name.

ENSDF is used for retrieval of datasets, their printout, for editing data catalogues for special data types (e.g. half lives) and now also for the production of tables containing nuclear and atomic radiations using the computer code MEDLIST originated by ORNL we received by support of the IAEA.

A detailed description of MEDLIST, its principles and also its applications one may find in /9/ and also /10/.

The implementation of MEDLIST at the institutes own ES 1040 computer is the major progress of the last year. Thus the code MEDLIST is the first time running on a computer of the unified series.

The code written by Ewbank and Kowalski produces based on ENSDF data sets and internal tabulations of atomic properties tables of nuclear (α , β^+ , β^- , γ) radiations and atomic radiations (X-rays: L, $K_{\alpha 1}$, $K_{\alpha 2}$, K_{β} , auger- and conversion electrons from K, L ... shells).

The tables are sorted by radiation type (auger-electrons, conversion electrons, X-rays, α , β , γ) and within this type by increasing energy. The radiations are flagged by an ordinary number. An adjustable low-intensity cutoff limits the number of radiations according to their intensity. The standard cut-off value is 0.1 %. A comment will be given if the number of omitted

radiations exceeds an other limit (standard 0,01 %). The intensity value is given as number of particles or photons per 100 desintegrations of the parent nucleus.

Uncertainty values stated in the ENSDF dataset for energy and intensity are carried through all calculations and are included in the table.

In addition to radiation type, energy in keV, intensity a fourth column contains the value for the energy emitted per desintegration. According to /9/ this value gives for an infinite homogeneous medium in which the source is contained with a concentration of $1 \mu\text{Ci/g}$ the absorbed dose in rads. An example of MEDLIST prepared data is given in fig. 3 for the beta minus decay of ^{234}Pa .

To illustrate the priciples of MEDLIST fig. 4 shows a part of an ENSDF dataset and the corresponding MEDLIST table.

The possibilities of the ENSDF datafile are complemented by the reference system NSR (Nuclear Structure References) its history had already been discussed /11/. The version of NSR now used has a structure according to Dunford /12/.

This new structure now allows a comfortable search in the SELECTRS field. This field contains automatically derived from the abstract (KEYWORDS) well defined "descriptors" in the following categories /11/:

A	Mass range or number
N	Nuclide or element for which structure or decay information is presented
T	Target
R	Reaction
M	Measured quantity
C	Calculated or evaluated quantity
Z	Z-range or number

Use and possibilities of this categories are shown in an example of NSR-entry fig. 5.

Using the possibilities of the USS-system a dictionary of all categories to serve as an aid in preparing requests to NSR had been prepared. This dictionary will be made available as

soon as possible.

Some conclusions should be discussed:

- An important entry not contained in the SELECTRS field is the energy of the incident particles in a nuclear reaction. This value should be added in a standardized way to allow its use in the formulation of requests.
- Only a limited number of verbal information is transmitted from KEYWORDS to SELECTRS to be stored under the categories M, D, C and X mentioned above.
This number (38) already allows an analysis. Terms not included must be found by a "free text search" in the KEYWORDS field.
- The number of terms included in M, D, C and X categories should be enlarged if any possible to diminish the use of the term OTHERS.

The list of SELECTRS entries makes it possible to perform a comparision of INIS and NSR. Such a comparision using other principles was already tried by Friedrich /13/. Till July 1982 the INIS magnetic tape version covered 681.107 documents /15/. NSR now contains 84.008 references of papers, books, reports, journal articles and so on containing nuclear structure and decay data for special nuclei.

A comparision of the occurrence of SELECTRS entries and corresponding INIS descriptors was made. The result is given in tab. 2 for the terms used in the M, D, C and X categories. The discussion of this values should take into account:

- The NSR file only includes references of data containing documents. That's why in a strong comparision only descriptors of data flagged documents should be regarded. The author did not have such a possibility.
- The terms used by NSR and INIS are quiet similar. The NSR terms are closer connected with the specialists idiom and therefore easier to handle.
- The value of the occurrence of INIS descriptors is that of used by indexer. Only in that case the document may contain numerical values of the corresponding term. In the

case of computer added descriptors one may find no data in this document.

Already the fact, that the NSR terms given in tab. 2 are taken from the categories M, C, D and X illustrates the good possibilities of finding relevant documents in this file. The additional possibility of using detailed access to reaction, target, nuclide guarantees for NSR a relevance for the retrieval impossible to be achieved by INIS.

In general all searches in NSR are performed as retrospektive retrievals. Technical reasons led to a subdivision into references from 1910 to 1975 and 1975 to 1981.

The SELECTRS field established now allows to connect the data file ENSDF and the reference file NSR in a more detailed manner (fig. 6). The central position of NUCLIDE is clearly visible. Special data files as there are the GAMDAT, Westmeier or WAPSTRA file may also be comprised in such a structure.

This picture (fig. 6) illustrates the possible degree of integration of both factographic and documental databases. This is achievable because of its same scope - nuclear physics.

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ORNL-5114
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occurring in Routine Releares from Nuclear Fuel Cycle
Facilities
ORNL/NUREG/TM-102
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National Nuclear Data Center, Feb. 1 1980
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- /15/ B. Saalbach, priv. com., Aug. 1982

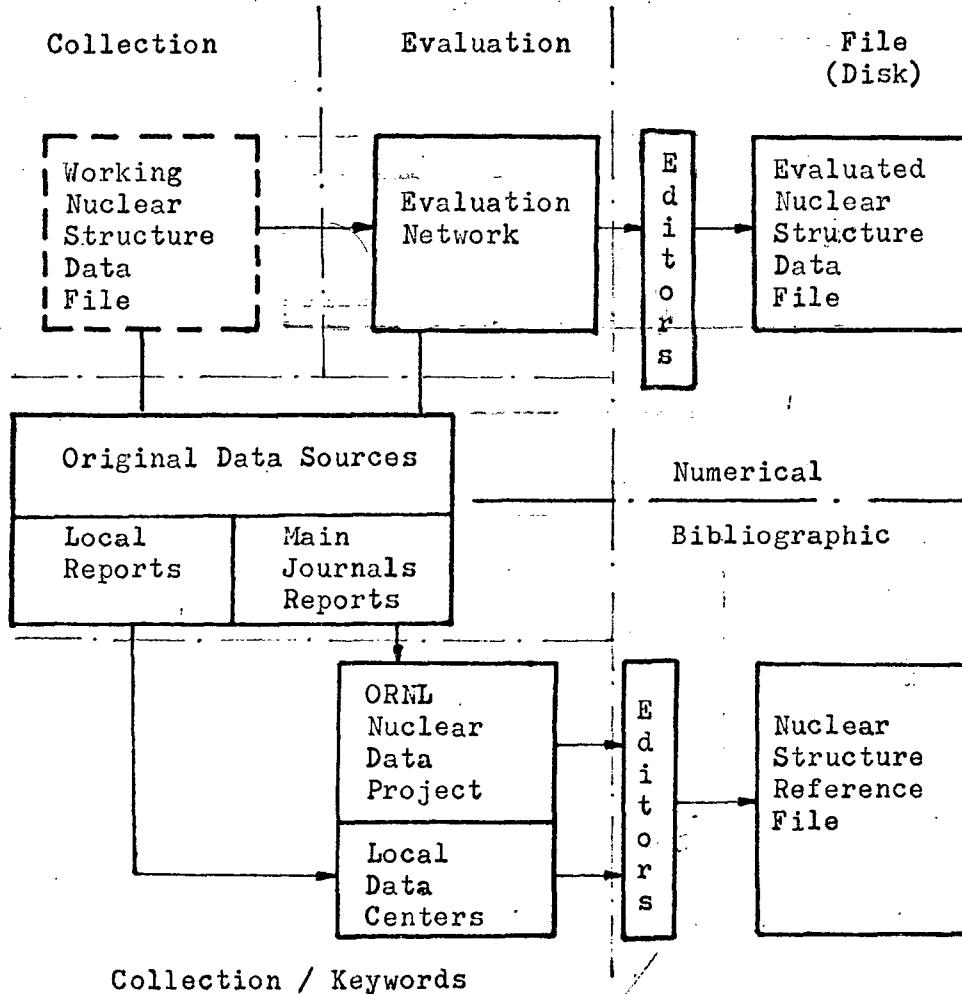
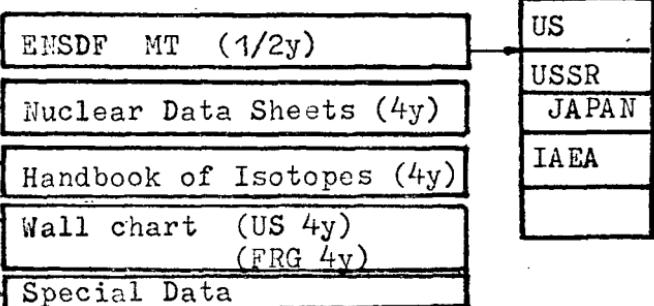


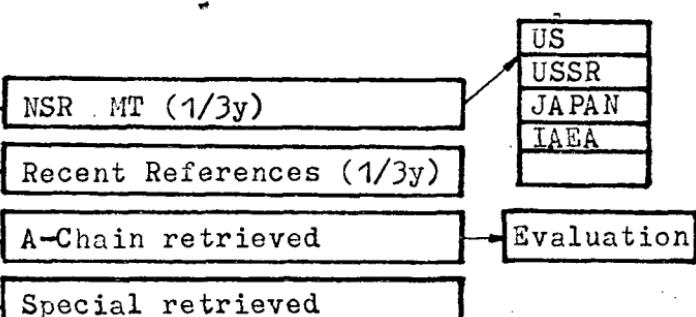
fig.1 : International System for the Evaluation of Nuclear

Publication
(MT, Book, Journal)



Data System

Data System



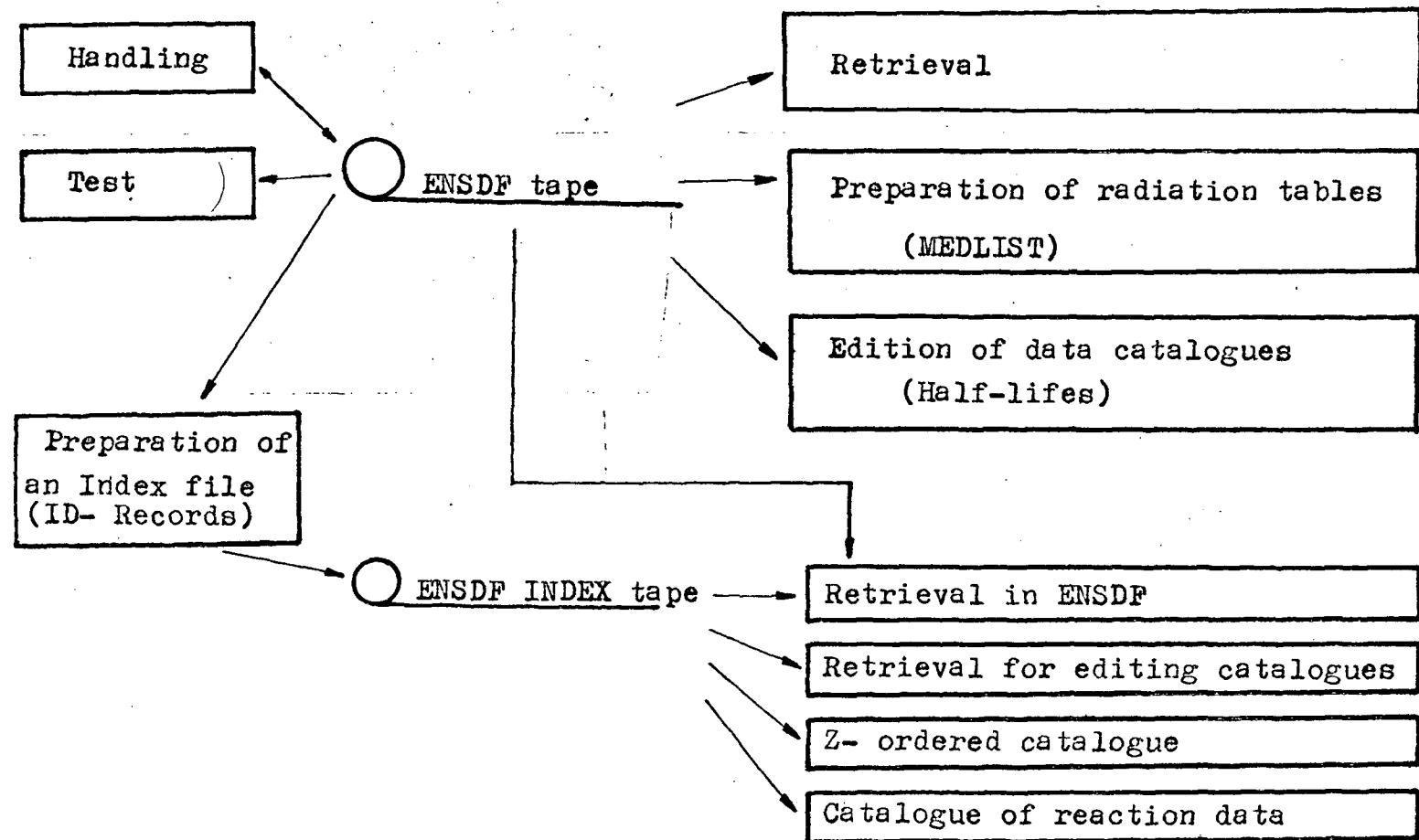


fig. 2: ENSDF, its use at ZfI Leipzig

234PA B- DECAY (1.17 M S) I(MIN)= 0.10%

RADIATION TYPE	ENERGY (KEV)	INTENSITY (%)	D(G=RAD/ MCY-H)
AUGER-L	9,89	0,36 5	0
GE-L-1	21,7426 3	0,4775 1	0,0002
GE-M-1	37,9520 4	0,1308	0,0001
GE-K-64	695,3939 16	0,4242	0,0063
B- 1 MAX	1236 5		
AVG	410,2 19	0,740 10	0,0065
B- 2 MAX	1471 5		
AVG	500,7 20	0,626 10	0,0066
B- 3 MAX	2281 5		
AVG	825,4 21	98,60 10	1,73
TOTAL B-		100,15 10	1,75
AVG	819,1 21		

19 WEAK B'S OMITTED (SUM(1B)= 0,19350%)

X-RAY L	13,6	0,46 5	0,0001
G 1	43,5	0,6541 1	0,0006
X-RAY K _A 2	94,6650 20	0,123 3	0,0002
X-RAY K _A 1	98,4340 20	0,199 4	0,0004
G 57	766,60 20	0,207 8	0,0034
G 82	1001,06 3	0,5892 1	0,0126

124 WEAK G'S OMITTED (SUM(1G)= 0,37311%)

fig. 3: Example of MEDLIST output using standard values of the code

236U 240PU A DECAY (GAMMAS) 77NBS WBE
 240PU P 0 6537 Y 10
 236U N 3.00 1 1
 236U GA E FROM E(A) TO G.S. AND E(G)
 236U GA IA FROM G+GE INTENSITY BALANCE
 236U G XK=21E-5 2 71GUZY
 236U G AG COIN 59TR07,68CUU6,69LE05
 236U GG E 72SL01,750T2X
 236U GG RI 72012X,71GUZY, OTHER 72CL2S
 236U L 0 0
 236U A 5168,3 73.0 3 1
 236U L 65.24 24 0.234 NS 6
 236U GL T 60UBE25,70T002
 236U A 5123 27.0 3 1.41
 236U G 65.242 6 0.0450 5 E8 600
 236U 2 G LC=437#MG=120#NT=39.7#
 236U 2 G L2/L3=1.05 5 M2/M3=1.40 5 58SA21
 : :

240PU A DECAY (6537 Y 10) I(MIN)= 0.10%

RADIATION TYPE	ENERGY (KEV)	INTENSITY (%)	D(G/RAD/UCI-H)
AUGER-L	9.89	8.7 13	0.0018
GE-L-1	23.485 6	14.7 7	0.0098
GE-M-1	39.694 6	5.40 18	0.0046
GE-NUP-1	43.801 6	1.79 6	0.0017
→ A 1	5123	27.0 3	2.95
→ A 2	5168,3	73.0 3	8.04

5 WEAK A'S OMITTED (SUM(GA)= 0.08540%)

X-RAY L 13.6 11.0 13 0:0032

13 WEAK G'S OMITTED (SUM(G)= 0.05247%)

fig. 4: Part of an ENSDF dataset (240PU α -decay) and corresponding MEDLIST prepared table

```

X   X   XXXX  XXXXX
XX  X   X   X   X   X
X   X   X   X   X   X
X   X   XXXX  XXXXX
X   X   X   X   X   X
X   XX  X   X   X   X
X   X   XXXX  X   X

```

NUCLEAR
STRUCTURE
REFERENCES

BY NUCLEAR DATA SERVICE
ZFI LEIPZIG / SYSTEM USS

USER 1 3 0001

79YA11 0002

<HISTORY> A800625
 <CODEN> JOUR IJARA 3U 123
 <REFERENCE> INTL JAPPL RADIAT ISOTOP 30 123
 (1979)
 <AUTHORS> MIYAGI, K; KONDO, A; YAMADERA,
 <TITLE> PRODUCTION OF 39CL AND 38S BY PHOTON
 NUCLEAR REACTIONS USING ARGON 8
 AS TARGET
 <KEYWORDS> NUCLEAR REACTIONS 40AR(GAMMA+P),
 (GAMMA+2P), (GAMMA+NP); E=30-65 MEV
 BREMSSTRAHLUNG; MEASURED PRODUCT
 ON RATES FOR 39, 38CL, 38S;
 <SELECTRS> T:40AR:AI REG(P):AI RI(G+2P):AI
 RI(G+NP):AI MOTHER:AI

fig. 5: Example of NSR- output

ENSDF dataset
(part only)

NSR reference

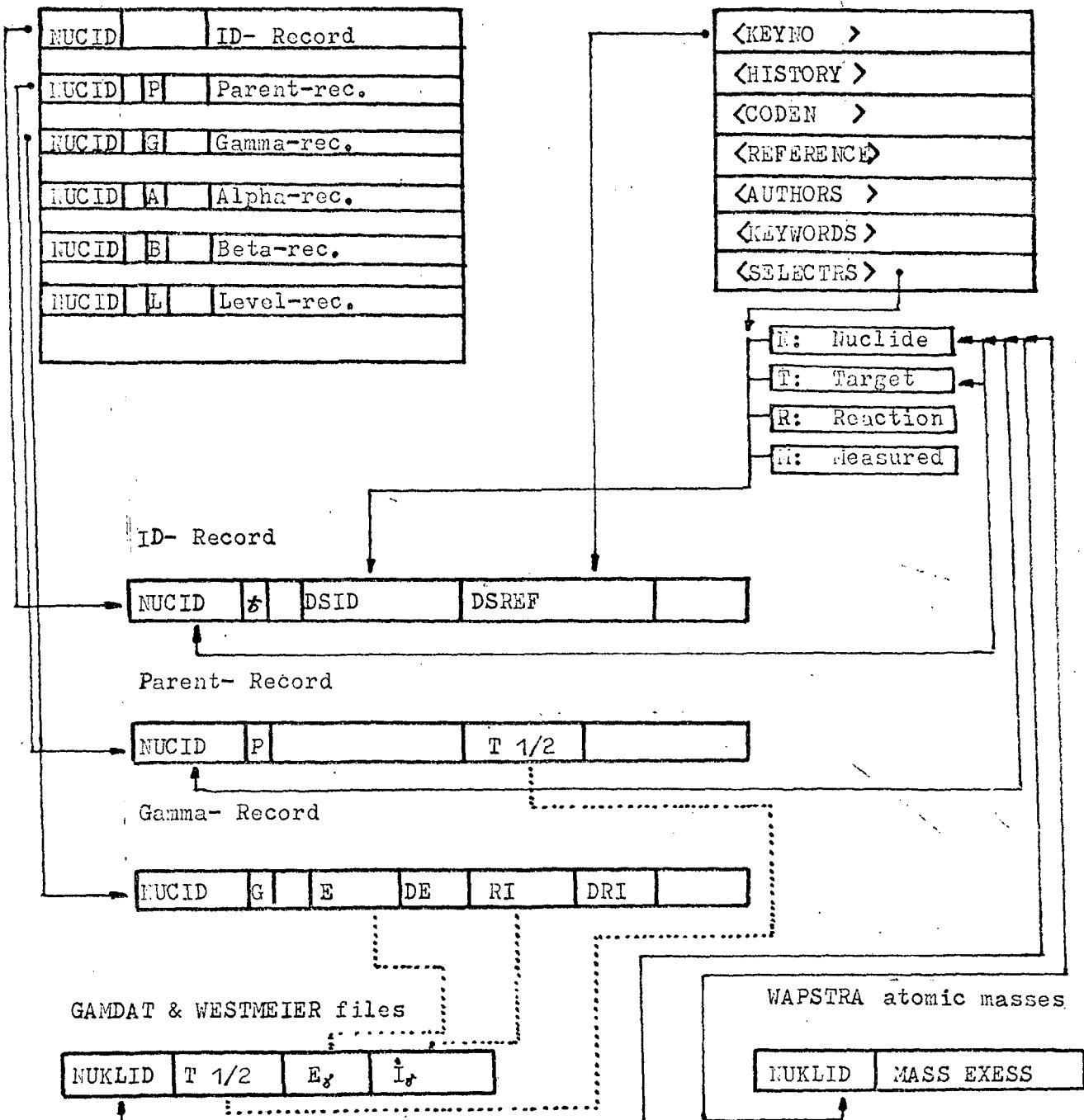


fig.6 : Interconnections of the various datafiles at ZfI Leipzig
(Nuclear structure and decay data - NSDD)

A- Range	Responsible NSDD Evaluation Groups
1 - 4	USSR
5 - 20	US / University of Pennsylvania
21 - 44	Netherlands / Utrecht
45 - 64	US / Nuclear Data Project
65 - 80	UK / Liverpool (incl. Kuwait)
81 - 100	FRG / Fachinformationszentrum
101 - 117	FR-BLG / (SWD / Lund 113)
118 - 129	JAP / JAERI
130 - 135	USSR
136 - 145	US / National Nuclear Data Center
146 - 152	US / Lawrence Berkeley Lab.
153 - 162	US / Idaho Nat. Eng. Lab.
163 - 194	US / Lawrence Berkeley Lab.
195 - 237	US / Nuclear Data Project
238,240,242,244	USSR
239,241,243	US / Nuclear Data Project
245 -	US / Nuclear Data Project

tab. 1: Responsibilities for the mass-chain evaluation in the international NSDD-Network

SELECTOR of NSR (C+D+M+X)	Occurrence NSR	Occurrence INIS	Term of INIS /14/
A=DECAY	202	927	ALPHA DECAY
A=SPECTRA	1.259	911	ALPHA SPECTRA
ANALOGS	1.133	-	-
B(LAMBDA)	3.672	-	-
B=DECAY	2.335	1.459	BETA DECAY
B=SPECTRA	2.236	692	BETA SPECTRA
BREMSSTRAHLUNG	89	4.158	BRMSSTRAHLUNG
CE	4.569	-	-
COULEX	518	1.011	COULOMB EXCITATION
DEFORmATION	867	1.618	NUCLEAR DEFORMATION
DOPPLER	1.448	173	DOPPLER COEFFICIENT
DSIGMA	27.501	4.694	DIFFERENTIAL CROSS S.
FISSION	1.271	3.137	FISSION
G=MULTIPOLARITY	3.393	1.408	MULTIPOLARITY
G=SPECTRA	19.457	7.659	GAMMA SPECTRA
H1	46	-	-
I=SHIFT	360	736	ISOMER SHIFT
LEVEL=PROP	14.811	10.904	ENERGY LEVELS
MESIC=ATOMS	118	130	MESIC ATOMS
MU	2.260	2.725	MAGNETIC MOMENTS
N=SPECTRA	440	3.449	NEUTRON SPECTRA
OTHER	49.165	-	-
P=DECAY	56	-	-
P=SPECTRA	66	1.062	PROTON SPECTRA
PARAMETERS	3.579	-	-
POLARIZATION	4.449	-	not comparable
Q	1.722	1.410	Q-VALUE
QUADRUPOLE	4.587	2.060	QUADRUPOLE MOMENTS
RADIUS	717	1.185	NUCLEAR RADII
RESONANCE	4.663	4.981	RESONANCE
ROT=BANDS	307	3.624	ROTATIONAL STATES
SIGMA	11.851	7.759	TOTAL CROSS SECTIONS
SPALLATION	28	802	SPALLATION
TTY	47	-	-
T1/2	8.500	2.993	HALF-LIFE
X=RAYS	635	3.304	X-RAY-SPECTRA
YIELDS	1.981	1.464	NUCLEAR REACTION YIELD
YRAST	147	662	YRAST STATES

tab.2 : Intercomparision of terms in the INIS thesaurus
and terms used in the SELECTORS field of NSR

database	file	size	reference system
NSDD	ENSDF	425,830 records 8,335 datasets	NSR 84,008 refs.
	GAMDAT'79	55,178 records 2,049 datasets	
	GSIGAM	22,540 + 45,411 records 2,311 datasets	
	WAPSTRA	1,992 records	
CPND	EXFOR	129,566 records 2,638 subent 431 entries	References CPND (ap. 16,920 refs.)

tab. 3: Content of the database for nuclear data at ZfI Leipzig (1982)